REMARKS

Claims 32-62 are pending in the present application. Claims 1-32 have been canceled. Claim 41-62 have been added. Claims 33, 36 and 39 have been amended. The specification has been amended. The abstract has been amended.

Applicant respectfully requests reconsideration of the application in view of the foregoing amendments and the remarks appearing below.

Objection to the Abstract of the Disclosure

The Examiner has objected to the abstract of the disclosure under MPEP § 608.01(b) because the first sentence repeats information in the title of the invention.

Applicant has amended the abstract, although has found it impossible not to repeat at least some of the information in the title of the invention, since the title consists of a short, concise description of the invention. That said, Applicant believes that the amended abstract should be acceptable because the first sentence does not contain both concepts contained in the title, i.e., the concepts of normal flow and a heat exchanger. Therefore, Applicant respectfully requests that the Examiner withdraw the present objection to the abstract.

Rejections Under 35 U.S.C. § 102(b)

The Nguyen Patent

The Examiner has again rejected claims 1, 3-8, 10, 19, 20, 22, 24-27, 33, 35, 36, 39 and 40 under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 5,016,707 to Nguyen, asserting Nguyen discloses a structure and method each containing all the elements of the corresponding claims. (Note that each underlined claim number indicates that claim is an independent claim.) Applicant respectfully disagrees.

Nguyen discloses a multi-pass cross-flow jet-impingement heat exchanger for transferring heat from a first fluid to a second fluid flowing in a direction perpendicular to the flow direction of the first fluid. The heat exchanger is made up of a number of plates, including end plates 10, 18, manifold plates 11-13, and core plates 14, 15. Core plates 14, 15 are provided in repeating pairs each consisting of one impingement plate 14 and one spacer plate 15. Each spacer plate 15 includes relatively large openings 15a, each for receiving a portion of the first fluid therethrough and directing it to a corresponding impingement region of an adjacent

impingement plate 14, or end plate 18 or manifold plate 13, as the case may be. Each impingement region includes a group of relatively small openings 14a for allowing the first fluid to pass therethrough.

Accordingly, the core of the Nguyen heat exchanger includes a plurality of parallel passageways for conducting the first fluid along a circuitous path through the core. Each of these passageways is defined by the large openings in the spacer plates 15 and corresponding groups of small openings in the impingement plates 14. The flow path of the second fluid through the passageways is defined between fins 14", 15".

Applicant has canceled claim 1-32. Therefore, the rejection is moot with respect to claims 1, 3-8, 10, 19, 20, 22 and 24-27.

Regarding the remaining ones of the rejected claims, as well as new claims 41-62, Applicant recognizes there are generally two ways to view the Nguyen heat exchanger. One is to view the passages carrying the first fluid, i.e., the passages formed by, e.g., openings 14a, 15a, as equivalent to the first and second manifolds of these claims. The problems with this interpretation in the context of the present claims are several. These include the fact that Nguyen's passages for the first fluid are not manifolds because they do not have a plurality of outlets or inlets. A manifold is a passage that fluidly communicates with a plurality of other passages, i.e., inlet passages or outlet passages. The Nguyen passages, on the other hand, are non-manifold passages that direct flow along only one path, albeit a circuitous one. In addition, the Nguyen heat exchanger does not have any interconnecting channels extending between the passages just discussed (formed by, e.g., openings 14a, 15a) and spaced along the longitudinal axes of these passages. Moreover, the Nguyen heat exchanger does not have any interconnecting channels configured so that substantially all of the heat transferred from the body to the fluid occurs as the fluid flows toward and substantially perpendicular to the heat transfer layer.

A second view is to consider the two openings 11a in Nguyen's manifold plate 11 to be manifolds, which is reasonable considering openings 11a, in one instance, provide the first fluid to a plurality of passages at openings 12a and, in the other instance, receive the first fluid from openings 12a. Under this view, it could be argued (improperly) that end plate 18 is an impervious heat-transfer layer defining a heat-transfer interface in accordance with the terminology of the claims. Applicant asserts such an assertion is improper because the Nguyen heat exchanger is a heat exchanger for exchanging heat internally from one fluid to another and

not for interfacing with a body so as to collect heat from that body. It could also be asserted that the passages formed by openings such as openings 14a, 15a are a plurality of interconnecting channels in accordance with the terminology of the claims.

However, similar to the first view of the Nguyen heat exchanger, there are several problems with this second interpretation in the context of the present claims. For example, end plate 18 is not a heat-transfer layer defining a heat-transfer interface for interfacing with a body that emits heat. Rather, Nguyen's end plate 18 provides a closure for each of the spaces in which the first and second fluids flow. In addition, the Nguyen heat exchanger includes only two openings 11a defining one inlet and one outlet manifold. Therefore, the various claims requiring a plurality of first manifolds located alternatingly with a plurality of second manifolds do not read on the Nguyen heat exchanger under the second view. Further, the interconnecting channels are not configured to so that substantially all of the heat transferred between the body and the fluid occurs as the fluid flow toward and substantially perpendicular to end plate. First, there is no body from which to collect heat. Second, even if a body were present, one of the liquids flows both toward and away from the end plate so that heat transferred therebetween would be transferred as the fluid flows both toward and away from the end plate. Moreover, a number of the present claims each require that a plurality of plates be stacked along the direction of the longitudinal axes of the manifolds so as to define the manifolds and the plurality of interconnecting channels. The Nguyen heat exchanger, on the other hand, is formed from plates that are stacked in a direction perpendicular to the longitudinal axes of the manifolds, i.e., openings 11a.

Applying these observations to the amended independent claims 33, 36, 39 and 40 rejected in view of the Nguyen patent, claims 33 and 36, as amended, each require, among other things: 1) at least one first manifold and at least one second manifold; 2) a plurality of interconnecting channels; and 3) a plurality of plates stacked along the longitudinal axes of the first and second manifolds. Again, as discussed above, under the first view of the Nguyen heat exchanger, the Nguyen heat exchanger does not include at least items 1 and 2 listed near the beginning of this paragraph. Under the second view, the Nguyen heat exchanger does not include at least item 3 listed near the beginning of this paragraph. Therefore, the Nguyen heat exchanger cannot anticipate claims 19, 33 and 36, as amended, and claims 20, 22, 24-27 and 35 that depend therefrom.

Regarding independent claim 39, as amended, this claim requires, among other things: 1) a first and second manifold extending along the length of the core; 2) a plurality of interconnecting channels spaced from one another along the length of the core; and 3) a step of stacking a plurality of plates along a direction parallel to the longitudinal axes of a first and second manifold. As discussed above, under the first view of the Nguyen heat exchanger, the Nguyen heat exchanger does not have at least items 1 and 2 listed near the beginning of this paragraph. Under the second view, the Nguyen heat exchanger does not have at least item 3 listed near the beginning of this paragraph. Therefore, the Nguyen heat exchanger cannot anticipate claim 39, as amended.

Regarding independent claim 40, this claim is directed to a method of providing a heat exchanger having a heat-transfer capacity that varies over the heat-transfer surface of the heat exchanger. The varying heat-transfer capacity is achieved by varying flow restrictions in the plurality of interconnecting channels over the heat-transfer surface. The Nguyen heat exchanger, on the other hand, has uniform interconnecting channels, i.e., the passages defined by openings such as openings 14a, 15a under the second view of the Nguyen heat exchanger discussed above, and no interconnecting channels in the context of the present invention under the first view of the Nguyen heat exchanger. Accordingly, the Nguyen heat exchanger cannot anticipate independent claim 40.

For at least the foregoing reasons, Applicant respectfully requests that the Examiner withdraw the present rejection.

Regarding new independent claims 41, 47, 48, 52, 57 and 58, each of these claims requires, among other things: 1) a heat-transfer interface adapted for thermally interfacing with a body; 2) a manifold region spaced from a heat-transfer layer; and 3) a plurality of interconnecting passageways that fluidly connect ones of a plurality of first manifolds to ones of a plurality of second manifolds and that are operatively configured so that substantially all of the heat transferred between a body and a fluid in the heat exchanger occurs as the fluid flows toward and substantially perpendicular to a heat-transfer layer having a heat-transfer interface for contacting the body.

As discussed above, under the first view of the Nguyen heat exchanger, the Nguyen heat exchanger does not include at least items 1, 2 and 3 listed in the immediately preceding paragraph. Under the second view, the Nguyen heat exchanger does not include at least items 1

and 3 listed in the immediately preceding paragraph. Therefore, the Nguyen heat exchanger cannot anticipate new independent claims 41, 47, 48, 52, 57 and 58 and claims 42-46, 49-51, 53-56 and 59-62 that depend therefrom.

The Chu et al. Patent

The Examiner has again rejected claims 1-6, 9, 10, 12-14, 19-27, 28-30, 33-35, 36, 39 and 40 under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 5,269,372 to Chu et al., asserting Chu et al. disclose a structure and method each containing all the elements of the corresponding claims. Applicant respectfully disagrees.

As discussed in the response to the first Office Action on the merits, Chu et al. disclose cold plate assembly 8 for cooling an electronic module. The assembly includes a plate 10 having kerfs 14,16 formed therein so as to form a grid of such kerfs that define a plurality of blocks. In one embodiment, the blocks are square with respect to the shape formed by the intersecting kerfs. In another embodiment, the blocks are rhomboidal. The kerfs contain a cooling fluid that collects heat from the plate 10 as the fluid flows past the blocks. A blind hole is drilled at each intersection between two kerfs to form either a conduit 17 or a conduit 18.

Conduits 17 and 18 are each in fluid communication with a corresponding finger channel 170, 180, respectively, formed in a manifold plate 148 located above the kerfs and blocks. Finger channels 170, 180 are in fluid communication with corresponding supply channels 172 and return channels 178, respectively.

Applicant has canceled claim 1-32. Therefore, the rejection is moot with respect to claims 1-6, 9, 10, 12-14, 19-27 and 28-30.

Regarding rejected independent claims 33 and 36, each of these claims, as amended, requires that a plurality of plates be stacked along the longitudinal axes of the first and second manifolds so as to define the manifolds and a plurality of interconnecting channels. The Chu et al. cold plate assembly does not have any such plates stacked along the longitudinal axes of the manifolds. Nor do Chu et al. suggest such a feature. Rather, like the Nguyen heat exchanger, the Chu et al. assembly comprises plates stacked perpendicular to the longitudinal axes of the manifolds in manifold plate 148. For at least this reason, the Chu et al. cold plate assembly cannot anticipate independent claims 33 and 36, as amended, nor claims 33-35 that depend therefrom.

Regarding independent claim 39, this claim, as amended, requires, among other things, a step of stacking plates along the longitudinal axes of the manifolds. As discussed immediately above, the Chu et al. cold plate assembly does not have plates stacked along the longitudinal axes of the manifolds. Therefore, the Chu et al. assembly cannot anticipate independent claim 39, as amended.

Regarding independent claim 40, this claim is directed to a method of providing a heat exchanger having a heat-transfer capacity that varies over the heat-transfer surface of the heat exchanger. The varying heat-transfer capacity is achieved by varying the flow restrictions in the plurality of interconnecting channels over the heat-transfer surface. The Chu et al. cold plate, on the other hand, has uniform interconnecting channels, i.e., the kerfs, having uniform flow areas. Accordingly, the Nguyen heat exchanger cannot anticipate independent claim 40.

Additionally with respect to independent claim 39, as amended, Applicant again asserts that Chu et al. do not disclose the specific relationship between the interconnecting channels (kerfs) and the first and second manifolds (finger channels) recited in claim 39. As Applicant asserted in the response to the first Office Action on the merits, claim 39, as amended, require that the manifolds extend along the length of the core, i.e., the longitudinal axes of the manifolds extend along the length of the core, and that the interconnecting channels be spaced from one another along the length.

However, Chu et al. do not disclose this relationship. This is so because the Chu et al. kerfs necessarily intersect with one another and are skewed relative to the finger channels. This geometry cannot satisfy the dual requirements of claim 39 that the manifolds extend along the length of the core and that the interconnecting channels be spaced from one another along the length.

For at least the foregoing reasons, Applicant respectfully requests that the Examiner withdraw the present anticipation rejection.

Regarding new independent claims 41, 47, 48, 52, 57 and 58, each of these claims requires, among other things, a plurality of interconnecting passageways that fluidly connect ones of a plurality of first manifolds to ones of a plurality of second manifolds and that are operatively configured so that substantially all of the heat transferred between a body and a fluid in the heat exchanger occurs as the fluid flows toward, and substantially perpendicular to, a heat transfer layer having a heat-transfer interface for contacting the body.

As also discussed in the response to the first Office Action on the merits, Applicant acknowledges that the kerfs of the Chu et al. device may be asserted to be the interconnecting channels of new claims 41, 47, 48, 52, 57 and 58. However, the object of the Chu et al. kerfs is to create a flow of working fluid parallel to the heat-transfer surface of the cold plate assembly, i.e., the lower exterior surface of plate 10 as viewed in FIG. 1, so that substantially all of the heat from the electronic module is transferred to the fluid as the fluid flow parallel to the heat-transfer interface. (See, e.g., Chu et al. claim 1, lines 12-14, "a plurality of flow channels formed into said plate and having directions of flow substantially parallel to said first surface . . . .") Therefore, the parallel flow within the Chu et al. interconnecting channels is perpendicular to the flow within the interconnecting channels of the new claims that is substantially perpendicular to, and toward, the heat-transfer layer. For at least this reason, the Chu et al. cold plate assembly cannot anticipate new independent claims 41, 47, 48, 52, 57 and 58 and claims 42-46, 49-51, 53-56 and 59-62 that depend therefrom.

The Messina Patent

The Examiner has again rejected claims 1-5, 10, 12-15 and 16 under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 5,309,319 to Messina, asserting Messina discloses a structure containing all the elements of these claims. Applicant respectfully disagrees.

Again, Messina discloses an integrated cooling system 10 for cooling a plurality of electrical components 162 mounted on a circuit board 160 using a cooling liquid 20. As seen in FIG. 1 of the Messina patent, the integrated cooling system 10 includes a two-part manifold structure 102, 104 that defines a chamber that contains circuit board 160, as well as "a bath of cooling liquid 170. Col. 7, lines 65-66. Manifold part 102 has a plurality of inflow and outflow ducts 110, 120 that communicate liquid to a plurality of cooling chambers 130 via corresponding liquid supplying and removing ducts 112, 122. In one embodiment, the inflow and outflow ducts 110, 120 conduct the cooling liquid in opposite directions from one another and each chamber is supplied by one of the inflow ducts 110 and vented by two outflow ducts 120. Each cooling chamber provides cooling for a corresponding electronic component 162. The flow of the cooling liquid with the cooling chamber is first toward the electrical component, across the surface of the electrical component and then away from the electrical component toward the liquid-removing ducts. See FIGS. 2, 3, 7 and 8.

In other embodiments (FIG. 5), a thermally-conductive slug 510 and/or a thermally-conductive piston 520 may be provided to the cooling chamber (not labeled), or the cooling chamber may be largely eliminated, as at circuit components 532 and thermally-conductive layer 540. However, in each of these cases the flow of coolant liquid is essentially the same as it is in the cooling chambers 130 of FIGS. 2 and 3. That is, the flow is first toward the electrical component, across, i.e., parallel to, the surface of the electrical component and then away from the electrical component toward the liquid-removing ducts.

Applicant has canceled claim 1-32. Therefore, the rejection is moot. However, new independent claims 41, 47, 48, 52, 57 and 58 contain a number of limitations similar to the limitations of the rejected claims. Therefore, Applicant addresses the Messina et al. patent in light of the new claims.

Each of new independent claims 41, 47, 48, 52, 57 and 58 requires, among other things, a plurality of interconnecting channels configured so that substantially all of the heat transferred between the body and the fluid occurs as the fluid flows toward and substantially perpendicular to the heat-transfer layer.

In contradistinction, the mechanism for the removing heat from the electrical components of the Messina patent is the flow of a cooling liquid across the electrical components or the thermally-conductive slug, i.e., parallel to the upper surface of the component. Thus the direction of flow in the Messina cooling system for removing heat from the electrical components is perpendicular to the flow within the heat exchanger of claims 41, 47, 48, 52, 57 and 58 that is perpendicular to the heat-transfer interface or surface. In this connection, it cannot be fairly argued that the flow with the supply and removing ducts 112, 122 removes any heat from the electrical components, since in any of the various embodiments, the electrical components are not in good thermal communication with manifold portion 102 that contains these ducts. This is readily seen in FIGS. 1-3, 5, 7 and 8, wherein it is shown that there is little, and in some cases, no contact between the electrical component/slug and manifold portion 102. Thus, there would be negligible, or no, transfer of heat from the electrical components to manifold portion 102 to be transferred to the working fluid in supply and removing ducts. 112, 122 Again, the heat transfer in the Messina system occurs as the cooling liquid flows over the electrical component or slug in a direction parallel to the heat-transfer surface/interface present there.

For at least the foregoing reason, the Messina cooling system cannot anticipate new independent claims 41, 47, 48, 52, 57 and 58 and claims 42-46, 49-51, 53-56 and 59-62 that depend therefrom. Therefore, Applicant respectfully requests that the Examiner withdraw the present anticipation rejection.

Rejections Under 35 U.S.C. § 103

The Nguyen Patent and Ordinary Skill in the Art

The Examiner has rejected claims 2, 9, 11, 17, 18, 21, 23, 34, and 37 under 35 U.S.C. § 103 as being obvious in view of the Nguyen patent, discussed above. The Examiner asserts Nguyen discloses a device having all of the elements of these claims except the number of first and second manifolds, the shapes of the manifolds being triangular, and the relative volumes of the first and second manifolds. The Examiner further asserts it would have been obvious to a person having ordinary skill in the art at the time of the invention in view of the level of ordinary knowledge in the art to change the Nguyen device such that it includes the elements of the recited claims. Applicant respectfully disagrees.

Applicant has canceled claim 1-32. Therefore, the rejection is moot with respect to claims 2, 9, 11, 17, 18, 21 and 23.

Regarding claims 34 and 37, these claims depend from independent claims 33, and 36, respective, discussed above in connection with the anticipation rejection in view of the Nguyen patent. As discussed above, Nguyen does not disclose all the features of these claims that the Examiner asserts are present, e.g.: 1) at least one first manifold and at least one second manifold; 2) a plurality of interconnecting channels; and 3) a plurality of plates stacked along the longitudinal axes of the first and second manifolds. In addition, ordinary skill in the art would not suggest providing these features to the Nguyen device. Rather, combining such features with the Nguyen device could only be done in hindsight of the present invention. This type of hindsight reconstruction is not permissible in formulating an obviousness-type rejection. Therefore, the asserted combination of the Nguyen teachings with ordinary skill in the art would lack at least the heat-transfer surface and plurality of first and second manifolds limitations required by each of claims 34 and 37.

For at least the foregoing reasons, the combination of the Nguyen patent and ordinary skill in the art cannot render claims 34 and 37 obvious. Therefore, Applicant respectfully requests that the Examiner withdraw the present rejection.

The Chu et al. Patent and Ordinary Skill in the Art

The Examiner has rejected claims 11, 17, and 18 under 35 U.S.C. § 103 as being obvious in view of the Chu et al. patent, discussed above. The Examiner asserts Chu et al. disclose a device having all of the elements of these claims except the relative volumes of the first and second manifolds. The Examiner further asserts it would have been obvious to a person having ordinary skill in the art at the time of the invention in view of the level of ordinary knowledge in the art to change the Chu et al. device such that it includes the elements of the recited claims. Applicant respectfully disagrees.

However, Applicant has canceled claim 1-32. Therefore, the rejection is moot. Accordingly, Applicant respectfully requests that the Examiner withdraw this rejection.

The Messina Patent and Ordinary Skill in the Art

The Examiner has rejected claims 9, 11, 17, and 18 under 35 U.S.C. § 103 as being obvious in view of the Messina patent, discussed above. The Examiner asserts Messina discloses a device having all of the elements of these claims except the cross-sectional shape of the first and second manifolds and the relative volumes of the first and second manifolds. The Examiner further asserts it would have been obvious to a person having ordinary skill in the art at the time of the invention in view of the level of ordinary knowledge in the art to change the Messina device such that it includes the elements of the recited claims. Applicant respectfully disagrees.

However, Applicant has canceled claim 1-32. Therefore, the rejection is moot. Accordingly, Applicant respectfully requests that the Examiner withdraw this rejection.

The Chu et al. and Bonde et al. Patents

The Examiner has rejected claims 15, 16, 31, and 32 under 35 U.S.C. § 103 as being obvious in view of the Chu et al. patent, discussed above, and U.S. Patent No. 5,099,311 to Bonde et al. The Examiner asserts Chu et al. disclose a device having all of the elements of these claims except a fluid recirculation system. The Examiner then states that Bonde et al. disclose a fluid recirculation system and asserts it would have been obvious to a person having ordinary skill in the art at the time of the invention to use the Chu et al. device with a fluid recirculation system. Applicant respectfully disagrees.

However, Applicant has canceled claim 1-32. Therefore, the rejection is moot. Accordingly, Applicant respectfully requests that the Examiner withdraw this rejection.

CONCLUSION

In view of the foregoing, Applicant submits that claims 32-62, as amended, are now in condition for allowance. Therefore, prompt issuance of a Notice of Allowance is respectfully solicited. If any issues remain, the Examiner is encouraged to call the undersigned attorney at the number listed below.

Respectfully submitted,

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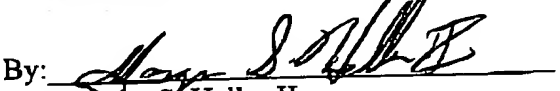
By: 

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